

The Electrochemical Behaviour of Aluminium Alloys in Neutral Solutions.

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Additions of alloying elements to aluminium provides the basis of many commercial aluminium alloys, which are employed in situations that exploit beneficial properties, including their high strength-to-weight ratio.

The role of certain alloying elements, such as copper in alloy strengthening has been examined, as well as the general effects of alloying elements in anodizing. The anodic oxidation of alloying elements in aluminium alloys in the presence of an amorphous surface film, which can be one of several types, such as produced by anodizing, electropolishing or chemical polishing, is frequently associated with the presence of a thin layer of alloy, a few nanometers thick, that is highly enriched in the alloying element relative to the bulk alloy [1-3].

In addition to enrichment of alloying elements at the alloy/film interface, local effects have been reported during anodizing aluminium alloys [4-6]. These have been related to the development of flaws in the anodic film above copper clusters at the metal-oxide interface and, regions of locally high alloying element contents in the alloy, such as second-phase particles.

In the present work, the electrochemical behaviour of selected aluminium alloys, such as Al-1 wt% Ag, Al-1 wt% Cu, Al-1 wt% Sn, Al-1 wt% Zn and Al-1 wt% Fe, for namely solution-heat-treated and solution-heat-treated and aged conditions, has been examined by potentiodynamic polarization in 0.1 M ammonium pentaborate solution and subsequent high resolution scanning electron microscopy.

From the results, it is immediately evident that the open circuit potential are dependent on the heat-treatment. Further, the current density in the passive region shows a similar dependency. Thus, for the aluminium alloys in solid solution the open circuit potential and the starting potential for aluminium oxidation is similar for all the alloys and, similar to that of high purity aluminium. However, for the solution heat-treated and aged aluminium alloys the open circuit potential depends on the particular aluminium alloy. Relating the previous information with the surface composition and morphology of the aluminium alloys, obtained by SEM, the displacement of the open circuit potential appears associated with the surface morphology and local compositions in the alloy surface. The electrode surface of aged aluminium alloys generally revealed light areas of local high alloying element contents, which are associated with intermetallic particles developed during ageing.

In addition to potentiodynamic experiments, polarisation resistance measurements revealed values higher values for the aged aluminium alloys than for aluminium of high purity. Solution heat-treated aluminium alloys showed polarization resistance values that are independent of the

alloying element, and broadly similar to that of high purity aluminium.

Finally, the polarisation resistance values for the solution heat-treated and aged aluminium alloys correlates well with the Gibbs free energy of oxide formation of the alloying element. Thus the higher the free energy of the oxide formation, the higher the polarisation resistance for alloy oxidation. The correlation between polarisation resistance measurements and Gibbs free energy of oxide formation of the alloying elements is suggesting that secondary processes proceeding at the alloy-film interface, possibly alloying element enrichment in the early stages of aluminium oxidation, are relevant to the electrochemical behaviour of aluminium alloys.

The authors are grateful to Fondecyt (grant 1000797) and to Dicyt/Usach for financial support.

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